Smart Traffic Control System using Embedded Web Technology

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***Abstract*- with rapid economic development in many countries, transportation has increasingly become an extremely important component in the national economy and daily life. So it is very essential to build an intelligent traffic control and monitoring system in order to resolve the traffic congestion of roads and reduce accidents. One major factor that affects the traffic flow is the management of the traffic at road intersections in a town or city. In traditional traffic monitoring system, each intersection is controlled by its own controller which sends signals to the intersection's traffic lights for changing their states. Each intersection controller works independently of each other with no way of being remotely monitored or controlled. With the rise of the Internet technology, embedded Web technology goes into the mainstream at present, and various web scripts and servers support the program running on an embedded device. The managers can manage and monitor traffic situations through the Web browsers. In this work we have utilized the emerging embedded web server technology to design a web-based traffic management system that can remotely control and monitor the traffic at various road intersections simultaneously. The system is aimed at improving the traditional traffic monitoring system by incorporating better management and monitoring schemes as well as providing road users with real time information.**

***Index Terms*- Embedded system, EWS, Flash ROM, TCP/ IP, Web browser.**

I. INTRODUCTION

There is a lot of useful information freely available about what the web is, how it came about, and the many nuances of what it means to use one technology over another. The Internet and the web are commonly interchanged despite being different parts of the same system. The Internet is infrastructure of hardware system that facilitates sending information. This hardware fits together to make the computer networks that in turn use Internet protocols such as TCP/IP and UDP/IP. "The Web" is short for the World Wide Web or WWW and it is complementary to the Internet. It is the series of various interlinked documents accessed through the internet. Ultimately WWW is a set of standards used to communicate information. There are two primary actors when communicating over WWW, the server and the client. For right now think of the server and the client as two desktop systems. The server system waits for the client system to initiate communication and then the client system makes a request for information. If the server system understands the request it replies with a response. If the server system does not understand the request it replies back to the client system with an error. This pattern is termed as the client-server model. To transfer information in this request-response manner both the web service and the web browser must talk the same computer language. That language is called as Hypertext Transfer Protocol or HTTP. HTTP is built on other standard protocols such as TCP/IP protocol. HTTP has 9 basic actions, which are called methods that it supports; the most common methods: GET and POST. A GET method makes request to the server system to retrieve information. A POST method makes a request to change information on the server system The program that runs on the server system and can communicate over HTTP is called the web service. A web service is an application used to handle web requests from the client system and reply with a response determined by the web developer. You can start and stop the web service just like any other type of computer program.

An embedded system is a computer designed for dedicated functionality such as controlling or monitoring. Typically they run a real-time operating system (RTOS) to allow for many deterministic

operations and high reliability. Similar to large website publishers like Yahoo, Google, or Facebook, embedded systems have information that needs to be shared with the external systems. Two common examples of such external systems would include human-machine interfaces (HMIs) and the supervisory control and data acquisition (SCADA) systems. Both external system types need to communicate with the embedded devices, but their requirements dictate different design decisions when using web technology. In this paper we have utilized the emerging embedded web server technology [1] [2] to design a traffic control and monitoring system that can remotely control and monitor the traffic at various road intersections simultaneously. The proposed system is aimed at improving the traditional traffic monitoring system by incorporating better management and monitoring schemes as well as providing road users with real time information.

II. RELATED WORK

In [3], the authors built a traffic surveillance technology system based on wireless sensors. Their system was deployed in freeways and at intersections for traffic measurements such as vehicle occupancy, count, speed, and vehicle classification which can't be obtained from standard inductive loops. In [4], the authors proposed a traffic control system that depends on the traffic information collected from the WSN to achieve a real time adaptive traffic control. In [5], the authors presented a new system that applied to the traffic control allowed designing and developing systems with a high level of autonomy and intelligent. The capacities of these kinds of system to manage and get acknowledge about traffic control were huge.

In [6], the authors presented the design and implementation of a sensor network system for monitoring the flow of the traffic through temporary construction work zones. Also, they implemented software architecture in TinyOS/ nesC for collecting a variety of traffic statistics, such as density, flow, vehicle trajectories, etc. In [7], the authors proposed an algorithm for preprocessing the traffic monitoring system that provided a set of services requests that were submitted simultaneously, like vehicle statistics, road traffic conditions, accident zone detection etc. Our proposed solution eliminated redundancies among similar requests efficiently and effectively thus reduced communication cost and increased network lifetime.

III. EMBEDDED WEB SERVER

A Web server can be embedded in to a device to provide remote access to the device from a Web browser if the resource requirements of the Web server are reduced. The end result of this reduction is typically a portable set of program code that can run on the embedded systems with limited computing resources. The embedded system can be utilized to serve the embedded Web documents, including static and dynamic information about embedded systems, to the Web browsers.

A. Resource Scarcity

The development of embedded web server (EWS) must take into account the relative scarcity of the computing resources. Embedded server must meet the device's memory requirements and limited processing power. General-purpose Web servers have evolved toward a multi-threaded system architecture that either dedicates a separate thread to each incoming connection, or uses a thread pool to handle a set of connections with a smaller number of threads. Thread or single process to every incoming connection is usually impractical due to the memory overhead required and, in some cases, to the lack of system support for multiple processes.

B. Reliability and Portability

Generally computer network devices require high reliability. As one embedded component of the network device, embedded server also must be highly reliable. Because it is a subordinate process, at least it must protect propagation of the internal failure to the whole system. EWS needs to run on a much broader range of the embedded system in RTOS environments that vary widely in terms of the facilities they provide, and with much tighter resource constraints than mainstream computing hardware. So it needs high portability.

C. Security

EWS must provide a mechanism to limit access to sensitive Data or configuration control. EWS should look to incorporate Secure Socket Layer (SSL) protocol, which ensure a secure socket connection between the browser and the Web server. There is also Secure-HTTP, an extension of HTTP for both

authentication and data encryption between a Web server and a Web browser. Even public and private cryptography technologies can be leveraged to control access to managed device. There are different levels of security in the Web environment from no security to simple, medium and strong security. Embedded web server developer must take into account for what security level is moderate to the Web-based element management system.

IV. ROPOSED WORK

The intelligent traffic control and monitoring system proposed in this paper consists of a master unit and a number of slave units sparsely located at different geographical sites and interconnected together through the internet. The master node is the Central Traffic Management Unit (CTMU) used to remotely monitor and control the different nodes using the internet technology as the communication backbone, as shown in Figure 1.

Each node is equipped with a EWS which is responsible for monitoring and controlling the traffic sensors, traffic signals, camera and/or the electronic variable message sign (EVMS) located at a specific intersection as shown in Figure 2. In this configuration, the CTMU acts as the client node while each node act as a server in a client-server model.

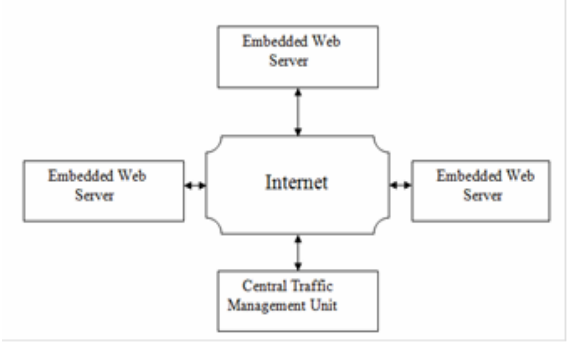

Figure 1: EWS Traffic Management System

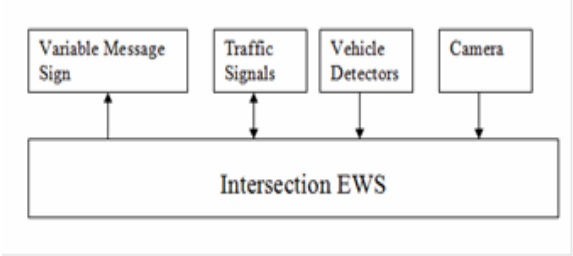

Figure 2: EWS in a node

Each EWS facilitates the process of sending and receiving data to and from remote locations and exchange information with one another via the CTMU, hereby, traffic problems can be detected, analyzed and corrected quickly. The ESW of every master and slave node is identified by its unique IP address and can be controlled remotely by CTMU. The embedded server sends and receives the desired information using HTML documents which has the ability to be generated dynamically using the Common Gateway Interface (CGI). HTTP protocol is the protocol that is used to allow the management unit to request status or control the web servers at the different nodes. The embedded web server must include enough memory to hold the software that facilitates its networking ability. An optimized TCP/IP stack is implemented into the web server ROM. In addition, external DRAM is required for buffering the incoming data, while an external flash memory is needed to store the html web information and the traffic signal control application software. The management unit will act as the web client when monitoring and controlling the nodes via a standard web browser.

A. System Structure

Our traffic monitoring (Figure 3) system consists of the data acquisition equipment (for multiple devices), remote monitoring host and the local Web server. The embedded remote monitoring system completes the data collection in the embedded platform and then provides the data to remote host through the TCP/IP protocol from Web server. It creates a condition to realize unattended management.

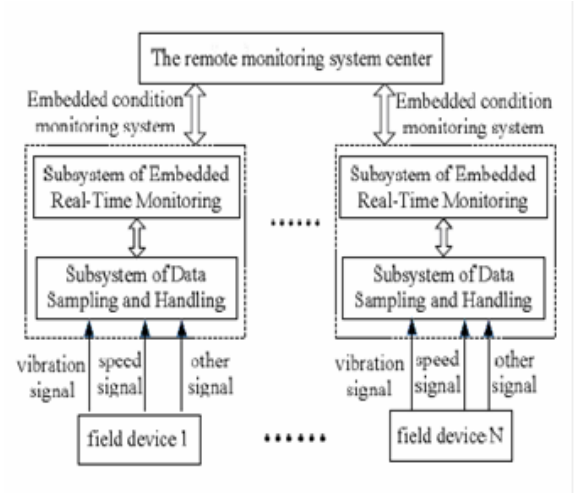

Figure 3: The structure of EWS traffic monitoring system

B. Embedded Web Server Hardware

Embedded web server hardware system includes an embedded ARM processor, DRAM, Flash ROM, Ethernet port, front terminal application system components and bus controller, as shown in Figure 4.The processor is Samsung S3C44B0X ARM7 that is suitable for quite poor working environment, supports uCLinux operating system, and it runs faster than 8-bit and 16-bit processor.

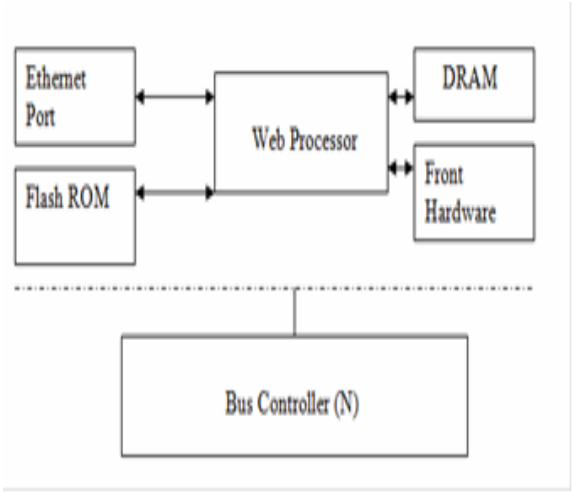

Figure 4: Hardware System

C. Embedded Web Server Software

EWS gathers real-time status information and then delivers them to the external database server. This method can easily make use of the database management software installed on the database server to implement data storage and management. Nevertheless, that happens at the cost of low real-time response capacity because of frequent data interaction between the embedded server and the external database server. Figure 5 explains the structure of the embedded web system and the embedded database management software transplanted in embedded web server is responsible for data storage and management. Embedded database management software has some special characteristics suitable for the embedded application environment. First of all, it always has small size, so it can be transplanted and used in the resource-limited embedded environment. For another, its process-driven access mode can efficiently avoid additional consumption caused by the process communication. Data dump should be considered, or the performance of the database accesses will gradually go down along with the data expansion.

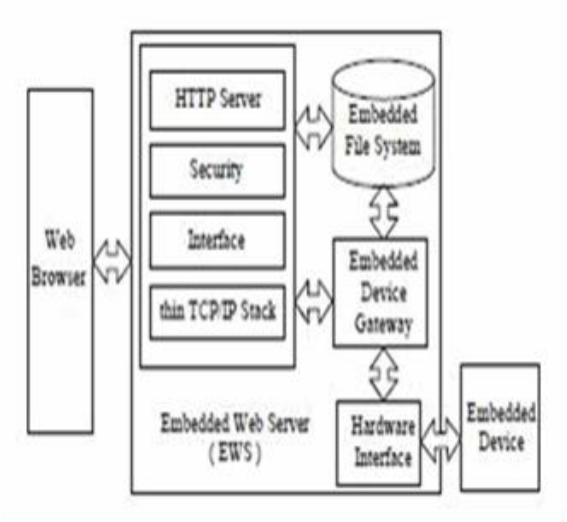

Figure 5: Software System

V. CONCLUSION

With the rise of the Internet technology, embedded Web server technology goes into the mainstream at present, and CGI script and Web server support the program running on an embedded device. The managers can manage and monitor situations of traffic through the Internet by using web browsers. This paper presents a method that combines embedded WEB technology with Internet to implement remote traffic control and monitoring through the Web Server applications. Therefore managerial personnel can have the remote real-time monitoring and control of traffic management through Web browsers without time and geographical constraints.

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